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Technical Note No 15

THE INCIDENCE OF SURFACE-BASED INVERSIONS AT HABBANIYA, IRAQ

by

R A Ebdon

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Please note: Permission to quote from this unpublished note should be obtained from AD Met O (SI), Meteorological Office, Bracknell, Berkshire.

The incidence of surface-based inversions at Habbaniya, Iraq

This investigation was carried out at the request of CAA (Airworthiness Division) to help meet a requirement for climatological information on surface-based inversions in order to assess the possible effects of an increase of temperature with height on the performance of an aircraft on take-off.

Introduction

Several publications exist which describe the statistics of inversions over the United Kingdom (1, 2) but a search of the literature yielded little or nothing, in a form suitable for the present purpose, for other parts of the World. It was therefore decided to carry out a pilot study by using the readily available data published in the Overseas Supplement to the Daily Weather Report of the Meteorological Office.

Attention was first concentrated on the data for Habbaniya, Iraq (33°22'N, 43°34'E) for the five Julys 1951-1955 (and later extended to the five Januarys of those years) when radiosonde ascents were carried out at 02-03 GMT (about 06-07 Local Time). Relatively strong surface-based inversions are to be expected at Habbaniya around dawn, especially in the summer months. Average temperatures there are:-

	January	July
Mean Temperature	9.4°C	34.4°C
Average Daily Maximum	15.6	44.4
Average Daily Minimum	4.4	25.6

and the results can be regarded as reasonably representative of airfields which experience a comparable arid or desert climate - eg Saudi Arabia, Algeria, Sudan etc and perhaps also some other semi-arid areas.

Extraction and Analysis of the data

The following details were extracted for each early-morning ascent:-

Date. Pressure (mb) and Temperature (deg F) at the surface, at the inversion top and at any other significant point reported below 950 mb. Temperature (deg F) at 950 mb (but 900 mb in 1955).

The resulting temperature changes expressed as deg F/mb were converted to deg C/100 feet from the surface to the inversion top and from the inversion top to 950 mb or, in some cases from the surface to 950 mb. These vertical temperature gradients were then used to estimate the temperature at 100 ft intervals from the surface to 1000 feet. Very occasionally there was a decrease of temperature with height from the surface and these cases were regarded as zero increase of temperature.

The inversion rate is usually greater close to the ground and decreases with height but, for the purpose of this investigation it was assumed to be linear. Slight underestimates of the frequency of occurrence of temperature increases from the surface to 100 ft and (to a lesser extent) 200 ft may result from this assumption, but the figures for higher levels should not be significantly affected.

As a check on the data eight extreme July inversions were examined in more detail by plotting the ascents for 02-03 GMT together with those for 12 hours earlier and later. None of these suggested that the data were suspect. The largest recorded increase which occurred in these five Julys was 13.3°C (from 993-971 mb) on 18 July 1954 (figure 1e) and the highest rate of increase was 2.31°C/100 ft (from 990-974 mb) on 28 July 1954 (figure 1g).

The results

Tables I and II show the percentage frequency of temperature increase (in one degree C ranges) at 100 ft intervals from the surface to 1000 feet in July and January respectively. For ease of comparison the results for both months are presented together in figure 2(a) to (h).

In interpreting these results it is necessary to bear in mind both the manner in which they have been obtained (ie assuming a linear lapse rate and estimating heights to the nearest 100 ft) and also the limitations in the accuracy of the original radiosonde data. Nevertheless, it is considered that, in spite of the limited period used, they provide a realistic estimate for aviation purposes of the nature and climatology of surface-based inversions around the dawn period at Habbaniya.

References

1. Best A C and Meade P J; The Incidence of Inversions over the United Kingdom. Met Office IDM No 74, 1956.
2. Hardy R M. Statistics of Inversions at Cardington in Bedfordshire. Met Office IDM No 108, 1973.

HABBANIYA JULY 1951-1955 02-03 GMT

TABLE I

Percentage frequency with approximate temperature increase equal to or greater than:-

155 obs

Approximate height (feet) surface to:-	10	9	8	7	6	5	4	3	Deg C
100									Increases of less than 3°C are not included in this table
200							4	10	
300					4	8	13	34	
400			4	5	10	19	34	53	
500	4	5	9	13	23	34	52	68	
600	6	9	13	23	33	43	63	79	
700	9	15	22	33	42	50	67	80	
800	12	18	29	40	48	61	78	87	
900	13	21	35	47	58	66	78	87	
1000	14	25	41	53	63	77	85	90	

HABBANIYA JANUARY 1951-1955 02-03 GMT

TABLE II

Percentage frequency with approximate temperature increase equal to or greater than:-

138 obs

Approximate height (feet) surface to:-	10	9	8	7	6	5	4	3	Deg C
100								1	Increases of less than 3°C are not included in this table
200								4	
300						1	7	24	
400					2	9	23	39	
500				3	10	21	36	51	
600			1	7	14	27	46	57	
700		1	4	9	14	36	50	59	
800		1	4	8	22	40	53	63	
900		2	4	12	24	40	53	67	
1000	1	1	5	13	26	43	55	70	

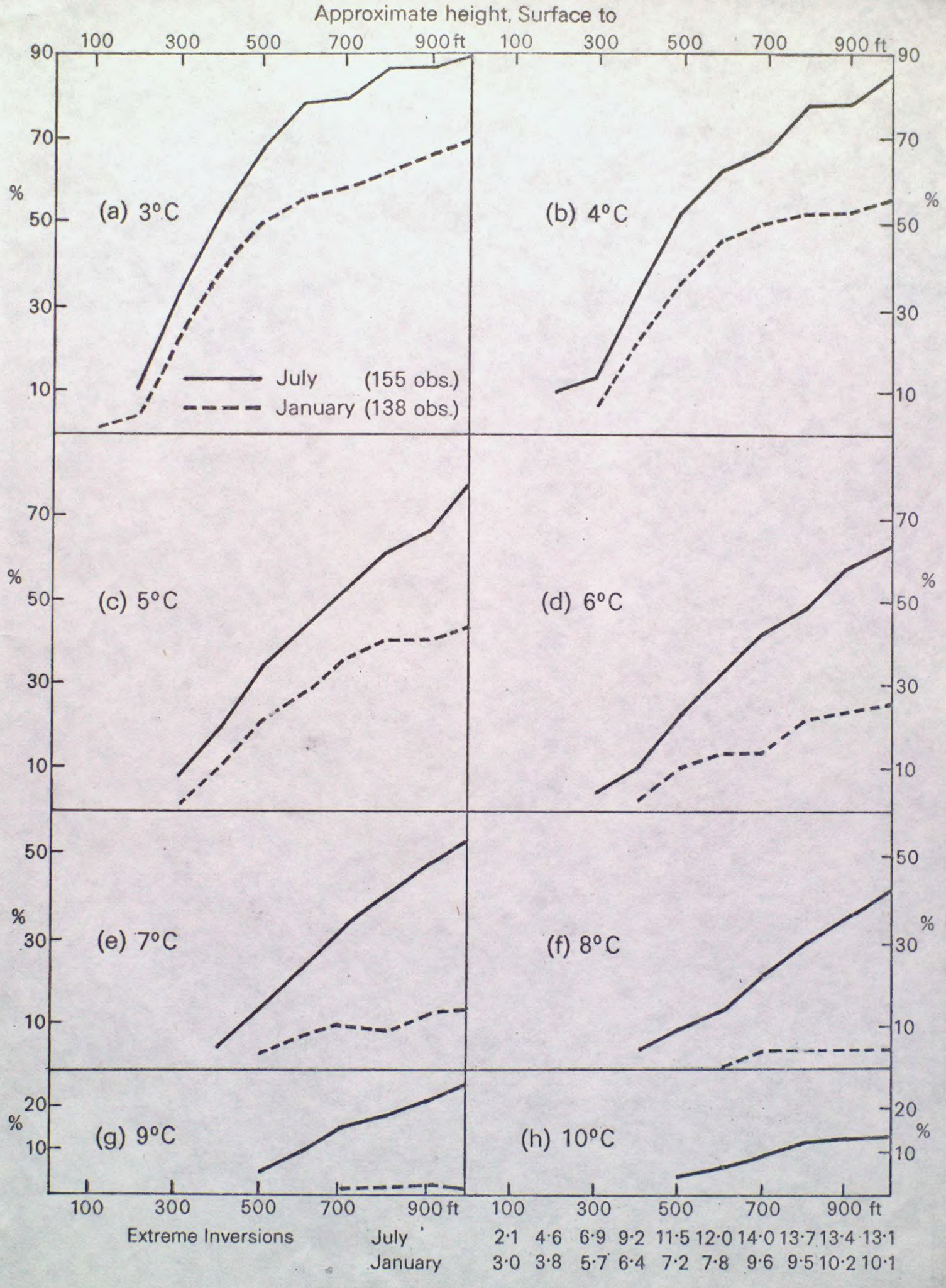
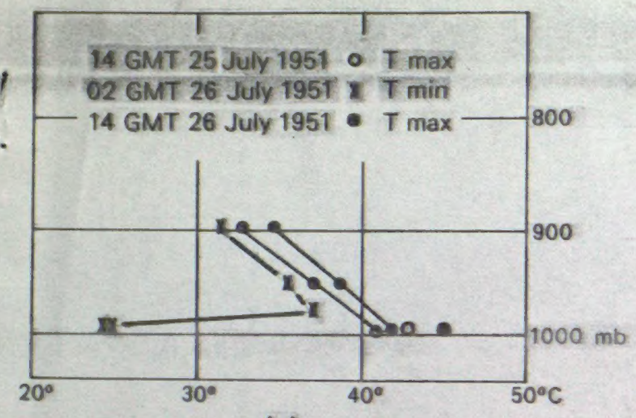


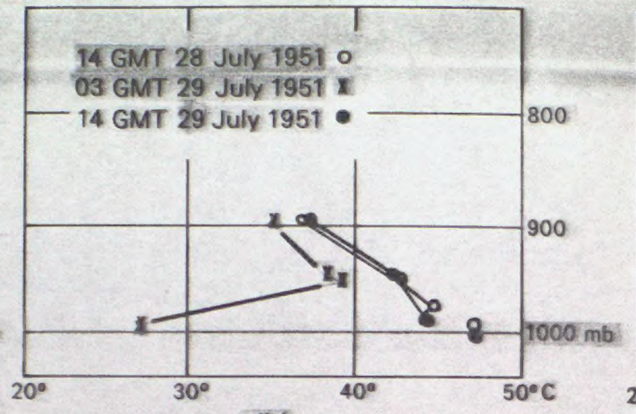
Figure 2 Percentage frequency with approximate temperature increase equal to or greater than the stated value. HABBANIYA 02-03 GMT using data for 1951-55



(a)

997 mb 25·0°C
976 mb 37·2°C
950 mb 35·6°C

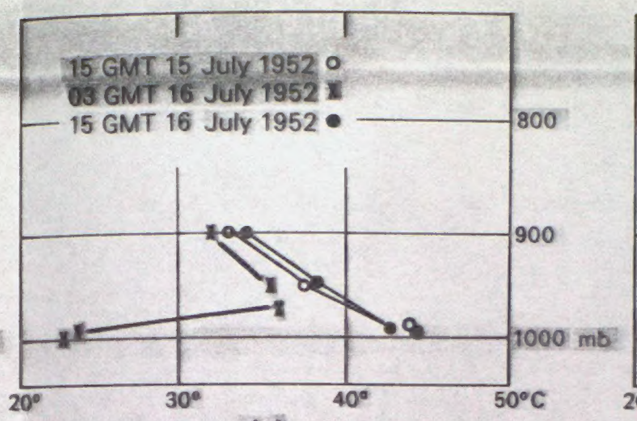
Increase of 12·2°C in 630 ft
1·94°C/100 ft



(b)

995 mb 27·2°C
953 mb 38·9°C
950 mb 38·3°C

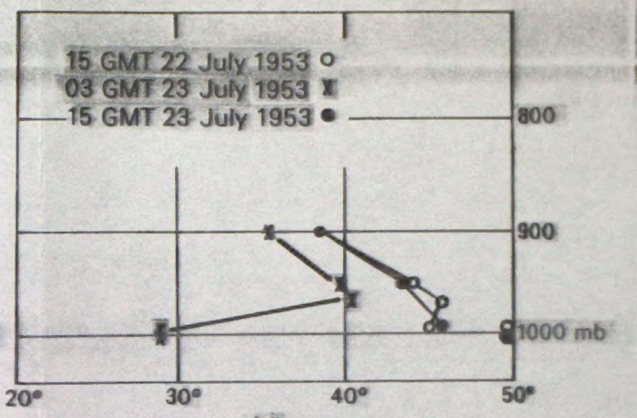
Increase of 11·7°C in 1260 ft
·93°C/100 ft



(c)

994 mb 23·9°C
970 mb 35·6°C
950 mb 35·6°C

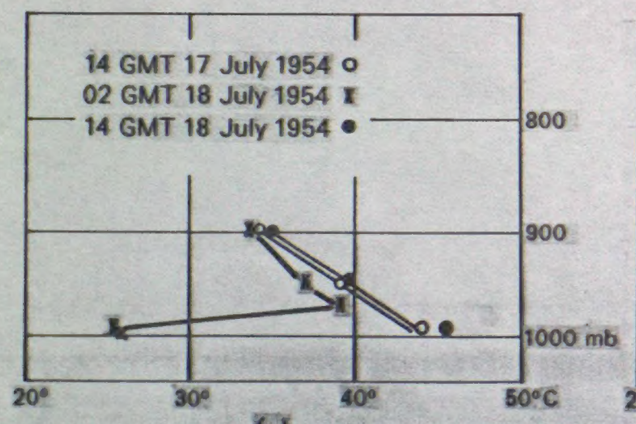
Increase of 11·7°C in 720 ft
1·63°C/100 ft



(d)

995 mb 28·9°C
964 mb 40·6°C
950 mb 40·0°C

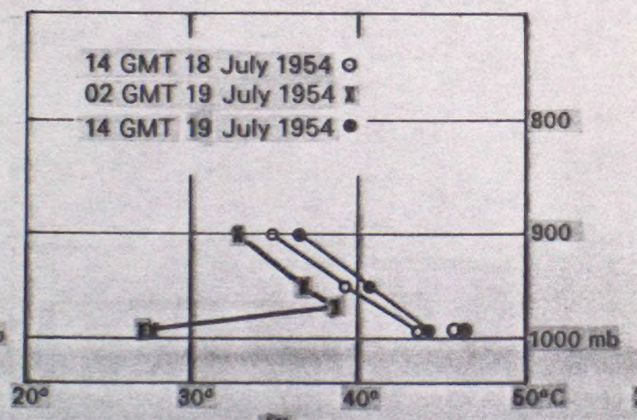
Increase of 11·7° in 930 ft
1·26°C/100 ft



(e)

993 mb 25·6°C
971 mb 38·9°C
950 mb 37·2°C

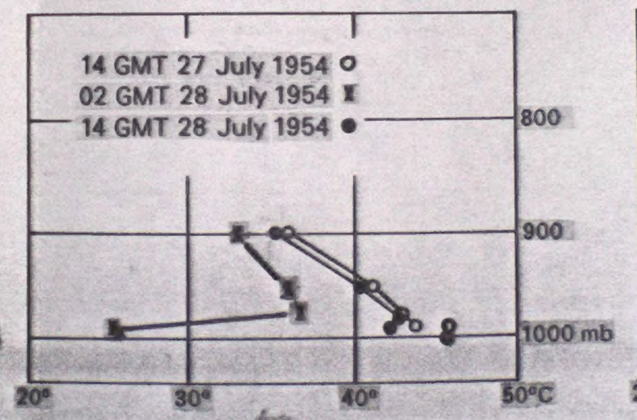
Increase 13·3° C in 660 ft
2·02°C/100 ft



(f)

994 mb 27·2°C
970 mb 38·9°C
950 mb 37·2°C

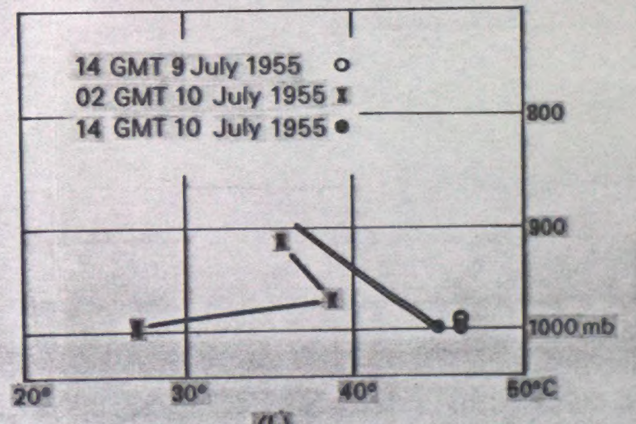
Increase of 11·7°C in 720 ft
1·63°C/100 ft



(g)

990 mb 25·6°C
974 mb 36·7°C
950 mb 36·1°C

Increase of 11·1°C in 480 ft
2·31°C/100 ft



(h)

996 mb 27·2°C
971 mb 38·9°C

Increase of 11·7°C in 750 ft
1·56°C/100 ft

A selection of intense surface based inversions at Habbaniya around dawn during the five Julys 1951-55 showing the ascents 12 hours earlier and later.